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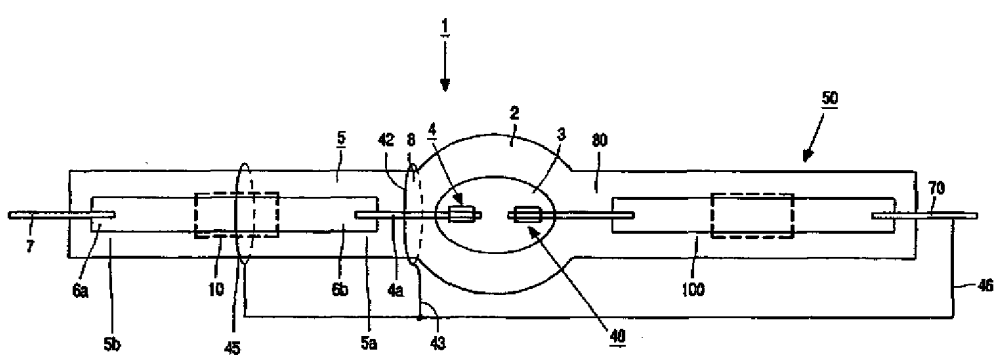
(54) Title: HIGH-PRESSURE DISCHARGE LAMP



(57) Abstract: The invention relates to a high-pressure discharge lamp provided with a discharge vessel made of glass which encloses a discharge space having an ionizable filling and an electrode. The discharge vessel is provided with a seal which encloses an Mo foil having knife edges and forms a feedthrough for an electric conductor to the electrode. At the location of the foil, the seal has a gastight sealed cavity and a first antenna on the outer side of the cavity. Preferably, a second antenna is placed at the neck where the seal is connected to the discharge vessel. This reduces both hot restrike voltage and hot restrike delay.

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High-pressure discharge lamp.

The invention relates to a high-pressure discharge lamp having a quartz glass discharge vessel which encloses a discharge space with a filling comprising at least a rare gas and Hg, in which a first electrode and a second electrode are present between which a discharge extends during lamp operation, and having a first seal incorporating an electric conductor which connects the first electrode to a metal wire projecting from the first seal to the exterior, said first seal having a first and a second gastight portion between which a gas-filled cavity is present.

A lamp of the type described is known from WO 97/48116. The known lamp is suitable for operation in air, i.e. free from an outer envelope. For lamps intended for an accurate formation of a beam by means of an optical system, this is an important advantageous aspect. Particularly for applications such as, for example, in projectors, and motor vehicle headlamps, the avoidance of optical disturbances caused by an outer envelope plays an important role. It is important that the temperature of the electric conductor has a relatively low value at the area where it is exposed to air, in order that a rapid oxidation of the conductor is prevented. In the known lamp, this is realized by elongating the seal by means of a second gastight portion spaced apart from the first gastight portion, between which a nitrogen-filled cavity is present. In this description and the claims, quartz glass is understood to mean a glass having an SiO_2 content of at least 95%.

In high-pressure discharge lamps, ignition delay often occurs in practice when igniting the lamp. The risk of an ignition delay strongly increases when the lamp has been in the dark for some time. The occurrence of ignition delay is a great drawback and, under circumstances, may lead to dangerous situations, for example, when using a high-pressure lamp as a motor vehicle headlamp.

It is an object of the invention to provide a measure for obtaining a lamp as described in the opening paragraph, in which the drawback described above is obviated.

According to the invention, a high-pressure discharge lamp of the type described in the opening paragraph is characterized in that the cavity comprises a further rare gas or a gaseous constituent of the filling or a combination of both, and in that the first seal has a first external antenna at the area of the cavity.

The lamp according to the invention has the advantage that, without detracting from the stability of the first seal obtained, the available cavity constitutes a start-promoting means as a source of UV radiation when applying an electric voltage across the cavity. The UV radiation source is referred to as UV enhancer.

Although it is preferred to position the UV enhancer as closely as possible to the discharge vessel, the provision of a cavity suitable as a UV enhancer in the first gastight portion of the first seal affects the mechanical strength of the first seal of the discharge vessel and is therefore not applicable in practice. For optimum beam properties of an optical system, minimal dimensions of the light source are desired, which is realized by choosing the distance between the first and the second electrode as small as possible. A practical result is that high to very high operating pressures occur in the discharge vessels of such lamps. Consequently, this imposes very strict requirements on the gastight seals of the discharge vessel. Positioning the UV enhancer at a larger distance from the discharge vessel, namely behind the first gastight portion surprisingly does not appear to detract noticeably from the ignition-promoting effect of the UV enhancer.

In an advantageous embodiment of the lamp according to the invention, the electric conductor is a foil which extends across a length of the first gastight portion, the cavity and the second gastight portion. On the one hand, this is a considerable simplification of the seal construction and its manufacture and, on the other hand, it has the important advantage that a strong concentration of an electric field is produced at the edges of the foil as soon as a voltage is applied to the conductor. This enhances breakdown in the UV enhancer.

The first seal in the lamp according to the invention is preferably a collapsed seal. This has the advantage that the glass has adhered to the electric conductor by means of flowing at the area of the first seal so that the gastight seal is free from internal stress to a considerable extent.

In a preferred embodiment of the lamp according to the invention, the first external antenna is electrically connected to the second electrode. A passive serial antenna combining a simple structure with a very reliable operation is thus realized.

In a further advantageous embodiment of the lamp according to the invention, the seal is connected to the discharge vessel at the area of a neck, and a second external

antenna is present at the area of the neck. Surprisingly, the positioning of the second external antenna provides the possibility of considerably reducing the possible ignition delay upon re-ignition of the lamp directly after it has been extinguished, which effect is further referred to as hot restrike. For reasons of a simple construction, the second external antenna is preferably connected electrically to the first external antenna. The first and the second external antenna may constitute an active system in which ignition voltage pulses are exclusively applied to the antennas. In the case of a passive system, the antennas are connected to one of the electrodes, preferably the second electrode. Both in the case of an active system and in the case of a passive system, the first external antenna enhances a substantially immediate breakdown in the UV enhancer as soon as an ignition voltage pulse is applied, and the second external antenna contributes to the realization of a minimal delay upon hot restrike of the lamp. The cavity already appears to function eminently as a UV enhancer if it contains only one rare gas. This may be the rare gas which forms part of the filling of the discharge vessel. However, it is alternatively possible for the cavity to contain another rare gas, referred to as further rare gas. Preferably, the gaseous constituent of the filling in the cavity comprises mercury vapor. This has the advantage that relatively much UV radiation is generated by the UV enhancer, which particularly contributes to a rapid and reliable hot ignition. A further advantage of the lamp according to the invention is that no separate mercury dosage appears to be necessary. This is easily realizable by making the first seal after the discharge vessel has been provided with its filling. For the purpose of electrical connection of the second electrode, the lamp is provided with a second seal for feedthrough of an electric conductor to the second electrode. For reasons of an efficient production of the lamp according to the invention, this second seal has the same construction as the first seal.

The first and second external antennas can be formed by separate pieces of wire, for example wound around the first seal. In an alternative embodiment, a single wire is wound around the first seal in such a way that both the first and the second antenna are formed. In an advantageous embodiment, each antenna is formed by a resilient clamp body which clips partly around the seal.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows a lamp according to the invention, comprising a collapsed seal,

Fig. 2 shows the collapsed seal of Fig. 1 in detail,
Fig. 3 shows a further embodiment of the lamp according to the invention,
Fig. 4 shows a seal provided with a resilient clamp body, and
Fig. 5 shows a side view of the resilient clamp body.

Fig. 1 (not to scale) shows a high-pressure discharge lamp 1 provided with a glass discharge vessel 2 which encloses a discharge space 3 with an ionizable filling, in which a first electrode 4 and a second electrode 40 are present, between which a discharge extends during lamp operation, and having a first seal 5 incorporating an electric conductor 6 in the form of a foil which connects the first electrode 4 to a metal wire 7 projecting to the exterior from the first seal, which first seal has a first gastight portion 5a and a second gastight portion 5b between which a gas-filled cavity 10 is present. The cavity comprises at least a gaseous constituent of the filling. For example, the cavity comprises mercury vapor. At the area of the cavity, the first seal has a first external antenna 45. The first seal is connected to the discharge vessel at the area of a neck 8. At the area of the neck, a second external antenna 42 is present which is electrically connected to the first external antenna by means of a conductor 43.

The first seal 5 constitutes a collapsed seal. The foil 6 is an Mo strip having knife edges. The metal wire 7 is secured to one end 6a of the strip, for example, by welding and projects to the exterior from the seal and from the discharge vessel. An electrode rod 4a of the first electrode 4 is secured to a further end 6b of the strip 6. On the side facing the first electrode 4, the discharge vessel of the second electrode 40 and a second seal 50, with a cavity 100 and a neck 80, has a comparable construction. The second electrode is connected to a wire 70. In the operating condition of the lamp, a discharge extends between the electrodes. In the embodiment described, the first and the second external antenna 45, 42 are electrically connected to the second electrode 40 by means of a conductor 46. A very reliable passive serial antenna is thus realized in an extremely simple manner.

Fig. 2 (not to scale) shows the first collapsed seal of the lamp of Fig. 1 in detail, in which Fig. 2A shows the first seal with strip 6 in a plan view and Fig. 2B shows it with strip 6 in a side elevation. In Fig. 2, the antennas 45 and 43 are not shown for the sake of clarity.

In a further embodiment of the lamp according to the invention, shown in Fig. 3, the first antenna 45 is a first wire loop of a wire 48 at the area of the cavity 10, which is wound with some turns around the first seal 5 as far as the neck 8 where it forms the antenna

42. This embodiment is advantageous because of the possibility of a simple construction of the antennas 45 and 42 and the conductor 46, formed from a single wire.

In an advantageous embodiment of the lamp, the antennas are formed as resilient clamp bodies. Fig. 4 shows (not true to scale) how the first seal is provided with such antennas. In the embodiment shown, the first seal, which has a substantially round circumference, is clamped by four resilient clamp bodies. A first resilient clamp body 45' located at the cavity forms the first antenna and a second resilient clamp body 42' located at the neck 8 forms the second antenna. A third resilient clamp body 44 is located close to the second gastight portion 5a of the first seal. The conductor 46 is connected to the resilient clamp body 44. A fourth resilient clamp body 47 is provided in between the the resilient clamp bodies 45' and 42'. The resilient clamp bodies 44, 42', 45', 47 are interconnected by connection bodies 401, 402, 403. Due to the presence of the cavity 10, the circumference of the first seal is somewhat larger at the cavity than on either side thereof. Preferably the fourth resilient clamp body is located immediately beside the larger circumference. The shown configuration has the advantage that the position of the first antenna 45' is substantially fixed in this way due to the differences in the circumference. A further advantage is that the antennas can be produced as separate lamp parts and can be mounted on the lamp in a simple way afterwards. Preferably, the resilient clamp bodies and the connection bodies are made in one piece. Fig. 5 shows a side view of the resilient clamp bodies 44, 45', 42', 47 and connection bodies 401, 402, 403 made in one piece.

In a practical realization of the lamp in accordance with the embodiment shown, the lamp is a high-pressure mercury discharge lamp having a nominal power of 120 W. The lamp, which is intended for projection purposes, has a discharge vessel with an internal diameter of 4 mm and an electrode distance of 1 mm. The discharge vessel has an ionizable filling which, in addition to mercury and a rare gas, for example, argon having a filling pressure of 100 mbar, also comprises bromine. During operation of the lamp, a pressure of 160 bar or more prevails in the discharge vessel. The discharge vessel is made of quartz glass having a largest thickness of 2.5 mm. The knife-edged strip is an Mo strip to which a metal wire is secured at one end. A W electrode rod of a first electrode is secured to the other end of the strip. The lamp is provided on each side with a collapsed seal each having a length of 28 mm. A length of 5 mm of the collapsed seal is already adequate for hermetically sealing the discharge vessel. The remaining length of the collapsed seal is used to give the temperature of the electric conductor a sufficiently low value at the area where it is exposed to air. Each collapsed seal has a cavity. Each collapsed seal has a length of 7 mm between the discharge space and the relevant cavity. Each cavity has a length of 5 mm.

The first seal of this practical realization is provided with a first antenna at the area of the cavity, in the form of a wire winding which extends in 2 to 3 turns as far the neck between the seal and the discharge vessel, where it forms a second antenna in a closed winding. The second antenna is spaced apart from the discharge space through a distance of between 1 mm and 3 mm. The wire has a diameter of .5 mm. The wire is electrically connected to a second electrode.

In a further practical realization the first seal is provided with four resilient clamp bodies made of an electrically conductive, heat-resistant material, in the described case stainless steel RVS310. The resilient clamp body located at the cavity has a width of 3mm. The other resilient clamp bodies each have a width of 1mm. The resilient clamp bodies are interconnected by connection bodies having a width of 2mm. The resilient clamp bodies and the connection bodies are made from one piece of material.

The lamp manufacture starts from a quartz glass tube in which a vessel is formed which is provided with tubular parts at two diametrically opposed locations, which tubular parts will serve for the manufacture of seals. First, a seal is made on the lamp vessel, for example a collapsed seal after a knife-edged strip and a conductor and electrode secured thereto in known manner have been provided, which collapsed seal is realized by heating the relevant tubular part in such a way that it softens and flows out under the influence of a prevailing sub-atmospheric pressure. This is preferably done by means of a laser beam rotating with respect to the tubular part, which rotating beam is moved from the conductor towards the electrode rod. By interrupting the laser beam at the location of the strip for some time, a gastight cavity is realized. The cavity thus formed comprises a gas which is present in the tubular part and the discharge space during manufacture of the collapsed seal. This is generally a rare gas with which the quartz glass tube is rinsed during manufacture of the seal. For reasons of an efficient manufacture, the rare gas which will form part of the filling of the discharge vessel will preferably be used for this purpose. Subsequently, the discharge vessel is provided with the constituents required for the filling, whereafter a knife-edged strip with secured electrode and ditto conductor is provided at the area of the other tubular part. Subsequently, a collapsed seal is made in a corresponding manner also in the other tubular part by heating and consequent flowing of the tubular part. The cavity thus formed is thus also automatically filled with vapor of the filling present in the discharge vessel, particularly mercury vapor. This is a great advantage for a satisfactory start-enhancing operation. It has been found that the collapsed seals thus formed qualitatively constitute equally good seals as in the case where the collapsed seals do not have a gastight cavity.

A practical lamp of the type described above requires a voltage of 1 kV for cold ignition, for example a voltage in the form of a high-frequency signal during 1 to 3 ms of, for example, 50 kHz for generating a breakdown in the cavity whereafter substantially instantaneously a discharge is produced in the discharge vessel between the electrodes, which will subsequently develop to a stable discharge arc so that the lamp operates in a stable manner. The lamp reaches its stable operating state after not more than 1 minute. In the same practical lamp, a maximum strike delay occurs after extinction of the lamp upon hot restrike of the lamp by means of a high-frequency signal of 5 kV of at most 60 s, with the power supplied during hot restrike to the lamp remaining limited to 120 W.

In the case of a comparable lamp without a cavity in one of the seals, the required ignition voltage is 20 kV under otherwise equal conditions.

CLAIMS:

1. A high-pressure discharge lamp having a quartz glass discharge vessel which encloses a discharge space with a filling comprising at least a rare gas and Hg, in which a first electrode and a second electrode are present between which a discharge extends during lamp operation, and having a first seal incorporating an electric conductor which connects the first electrode to a metal wire projecting from the seal to the exterior, said first seal having a first and a second gastight portion between which a gas-filled cavity is present, characterized in that the cavity comprises a further rare gas or a gaseous constituent of the filling or a combination of both, and in that the first seal has a first external antenna at the area of the cavity.

2. A lamp as claimed in claim 1, characterized in that the electric conductor is a foil which extends through a length of the first gastight portion, the cavity and the second gastight portion.

3. A lamp as claimed in claim 1 or 2, characterized in that the first seal is a collapsed seal.

4. A lamp as claimed in claim 1, 2 or 3, characterized in that the first external antenna is electrically connected to the second electrode.

5. A lamp as claimed in claim 1, 2, 3 or 4, characterized in that the seal is connected to the discharge vessel at the area of a neck, and in that a second external antenna is present at the area of the neck.

6. A lamp as claimed in claim 5, characterized in that the second external antenna is electrically connected to the first external antenna.

7. A lamp as claimed in any one of the preceding claims, characterized in that the gaseous constituent of the filling in the cavity comprises mercury vapor.

8. A lamp as claimed in any of the preceding claims, characterized in that the first external antenna is formed by a resilient clamp body which clips partly around the seal.

9. A lamp as claimed in claim 8, characterized in that each antenna is formed by a resilient clamp body which clips partly around the seal.

10. A lamp as claimed in claim 9, characterized in that the resilient clamp bodies are interconnected by a connection body and that the resilient clamp bodies and the connection body are made from one piece of material.

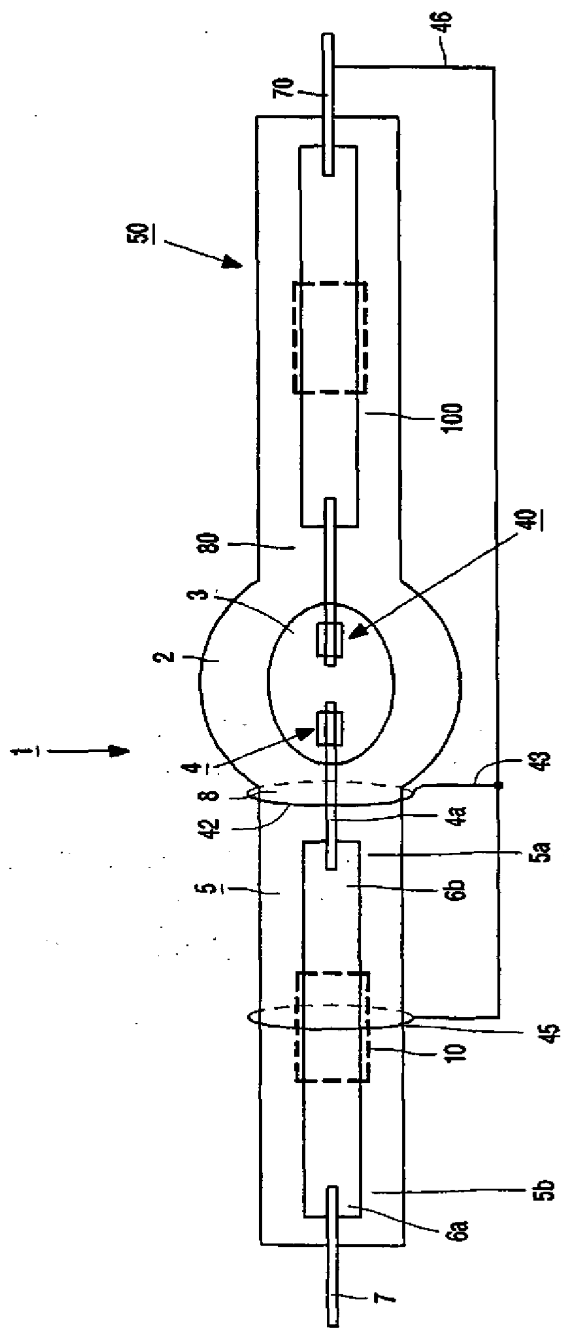

FIG. 1

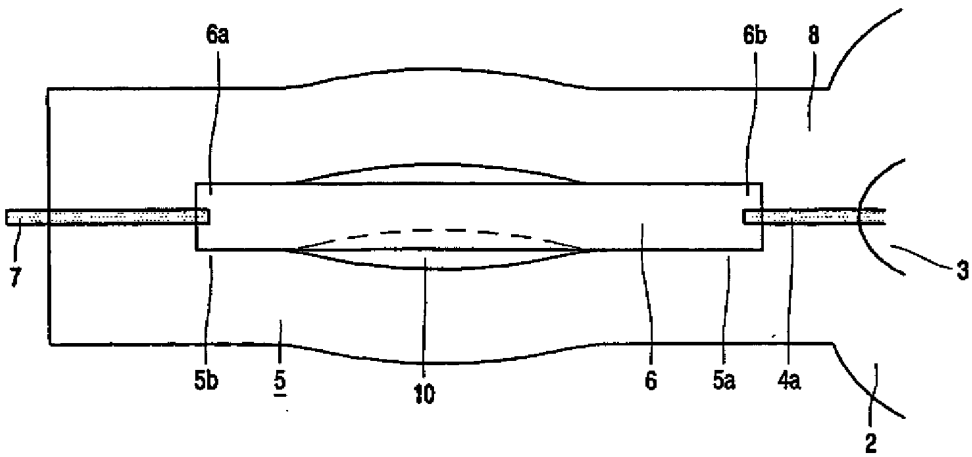

FIG. 2A

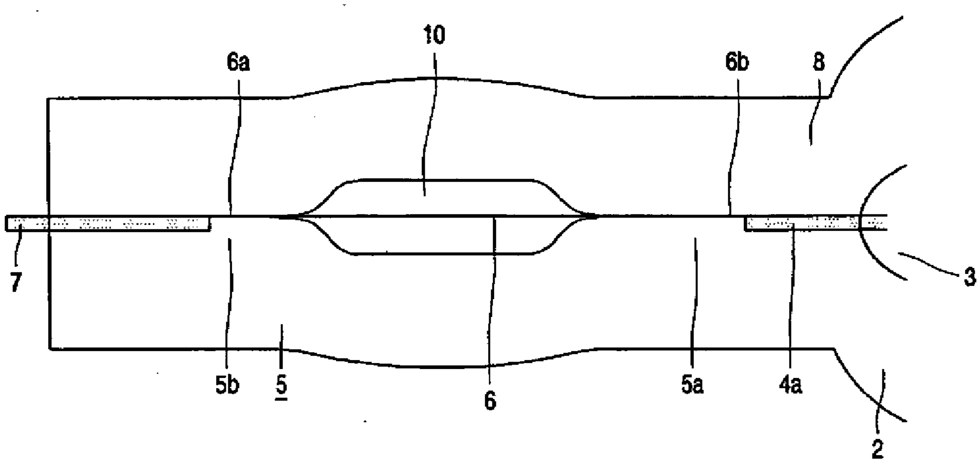

FIG. 2B

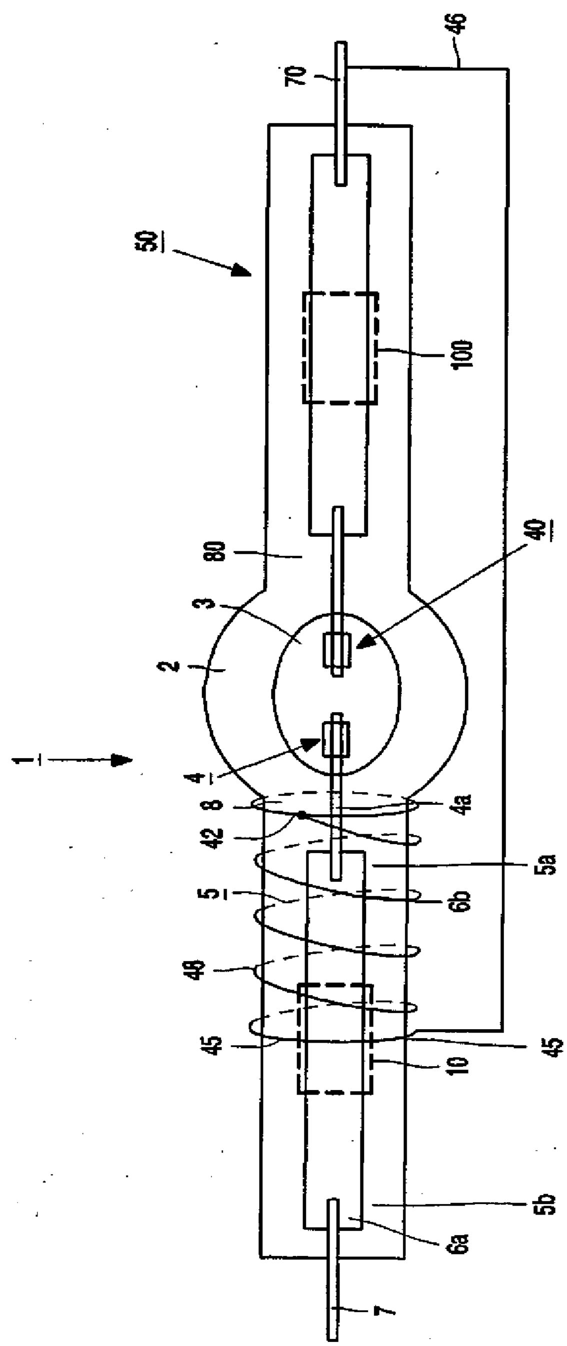

FIG. 3

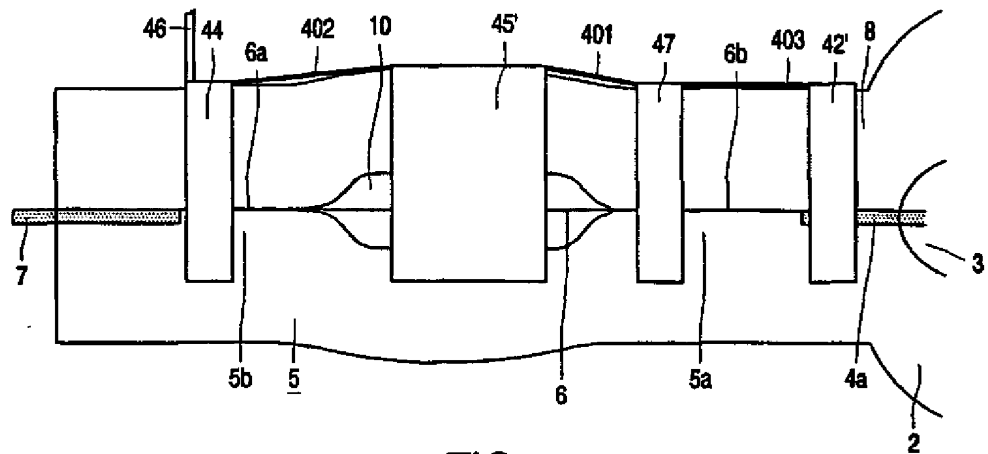
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FIG. 4

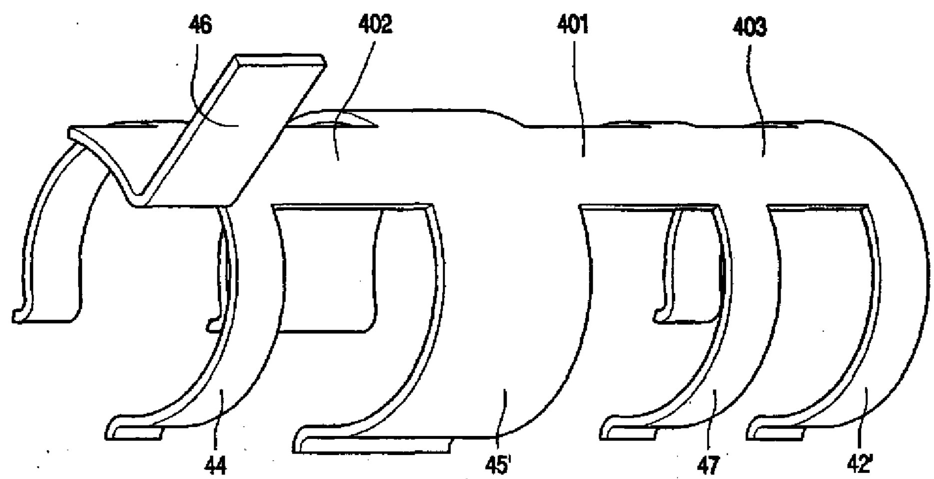
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FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 00/05579

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01J61/54

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0 313 027 A (GTE PROD CORP) 26 April 1989 (1989-04-26) claims 1-3,9,10,14; figures 1-6	1-3

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
18 October 2000	25/10/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Deroubaix, P

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INTERNATIONAL SEARCH REPORT

Inte. ...onal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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